

9 Sediment Monitoring

October 1, 2001 – December 31, 2002

Tim McLaughlin¹



Grassland Bypass Project

¹ Physical Scientist, U.S. Bureau of Reclamation, Mid-Pacific Regional Office, 2800 Cottage Way, Sacramento, California 95825 (916) 978-5046, tmclaughlin@mp.usbr.gov

Purpose

Sediment monitoring for the Grassland Bypass Project (Project) focuses on measuring selenium and organic carbon parameters in the San Luis Drain (SLD), Mud Slough, and Salt Slough. The purpose of the monitoring is to assess the selenium concentrations in the sediment samples during the 9-year life of the Project's second phase. The measurements within the SLD provide selenium concentration estimates for comparison with California Department of Health Services' hazardous waste criterion. The measurements in Mud and Salt Sloughs provide selenium concentrations for comparison with US Fish and Wildlife Service thresholds for ecological risk.

Sampling Locations

Sampling locations for sediment monitoring in Mud Slough are located at Sites C, D, I2, and E and in Salt Slough at Site F. Sampling locations in the SLD are based on a probability sampling scheme associated with the amount of sediment estimated within each Check. Table 9 depicts how the 20 annual samples were chosen and the location. The estimated cubic yards for each check came from the annual survey made in November 2001 by the San Luis & Delta-Mendota Water Authority (Chapter 9, Annual Report, WY 2001, May 2003).

Sampling Frequency

Quarterly sampling periods were March, June, September and November for the 12-month period covered by the second year of Phase II. The program went a calendar year accounting system for Phase II. Sampling periods continue to correspond with the biota sampling events of the USFWS within the sloughs. Annual measurements are made in the SLD.

Sampling Methods

Sediment samples are collected using an acrylic coring device (4.5 cm diameter, 38 cm internal length). After collecting the sediment, sections of the core, 0-3 cm and 3-8 cm, are slowly extruded using a non-metallic internal pushing device and placed in distinct quart size mixing bowls. An additional sample is collected near the same spot for the whole-core sample and placed into a third mixing bowl. The process is continued until three samples along a transect are completed. Material from the 2nd and 3rd samples are placed in the corresponding 0-3 cm, 3-8 cm and whole-core mixing bowls containing the 1st samples. Each of the mixing bowls contain material from the transect. The 0-3 cm, 3-8 cm, and whole core samples are then mixed well in their mixing bowls in a manner similar to kneading bread. The mixing objective is to obtain one homogeneous sample in each of the bowls. Composited samples are then placed in a wide-mouth polyethylene container and stored in an ice chest at 4°C. Only whole-core samples are collected for the SLD.

Results

Tables 1 to 9 list the results of sediment analysis of samples collected between 1996 and 2002 from Mud Slough, Salt Slough, and the San Luis drain. All values are based on dry weight.

Figures 1 through 7 depict the selenium information with the help of bar charts. Figure 8 depicts the results of annual sediment whole core analysis at locations in the San Luis Drain. Further discussion is limited to selenium concentrations only. Data are compared to the following:

Guidelines (for Mud and Salt Slough):

- The recommended ecological risk guidelines for selenium concentrations in sediment (Table 1, Chapter 7) are as follows: “no effect” - less than 2 µg/g, dry weight, “level of concern” - 2 to 4 µg/g, dry weight, and “toxic” - greater than 4 µg/g, dry weight.

Criteria (for the San Luis Drain):

- The California Department of Health Services established a criterion for selenium concentration in sediment of 100 µg/g wet weight. Should the selenium concentrations in sediment from the SLD exceed this value, material dredged from the drain would have to be deposited in a hazardous waste site.

Ecological risk: Mud and Salt Slough

Selenium concentrations in the sediment from Mud Slough (Sites C, D, and E) and Salt Slough (Site F) were all below the 2.0 µg/g (“no effect level”) for all 5 quarterly sampling periods representing the 1st year of Phase II. Selenium concentrations in the sediment from Mud Slough (Site I2) exceeded the 4.0 µg/g (“toxic effect level”) for all periods.

Hazardous waste material criteria: San Luis Drain

Results from the annual survey are also depicted in table 1. The highest value from the 20 samples was 47 µg/g, dry weight. To make the comparison for hazardous waste criteria, the data needs to be converted to a wet weight basis. The formula used to make the comparison is as follows:

$$\text{wet weight} = (\text{dry weight } \mu\text{g/g}) * (1.0 - \text{percent moisture}/100.0).$$

The conversion for the value of 47 provides a wet weight concentrations of 20 µg/g, well below the standard.

Table 1. San Luis Drain (Station A) Sediment Monitoring Results

Sampling Date	0-3 cm ug/g, dry weight	Selenium Concentration		Whole Core ug/g, dry weight	0-3 cm %	3-8 cm %	Organic Carbon %	Whole Core %	0-3 cm %	3-8 cm %	Percent Moisture %	Whole Core %
		0-3 cm ug/g, dry weight	3-8 cm ug/g, dry weight									
Mar-13-1996	2	16	10	3.90	3.60	3.40	83.3	79.1	83.3	79.1	80.5	80.5
Jun-27-1996	8	20	29	4.33	5.01	2.96	83.8	78.3	83.8	78.3	71.2	71.2
Sep-04-1996	3	24	8	4.35	2.72	4.10	81.2	81.2	81.2	73.3	76.0	76.0
Nov-12-1996	22	62	55	2.92	3.10	3.72						
Mar-12-1997												
Jun-10-1997	3	4	5	0.89	1.55	2.10	55.0	58.0	55.0	58.0	62.0	62.0
Sep-11-1997	38	56	50	1.52	2.18	1.95	70.6	75.7	70.6	75.7	70.2	70.2
Nov-18-1997												
Mar-03-1998	18	150	98	1.21	2.89	2.28	52.9	63.3	52.9	63.3	65.0	65.0
Jun-04-1998	3	12	7	0.58	1.58	1.03	35.2	54.9	35.2	54.9	50.0	50.0
Sep-28-1998	9	23	52	1.06	1.17	2.25	55.0	55.3	55.0	55.3	67.9	67.9
Nov-10-1998	27	140	31	1.55	2.61	1.43	71.0	60.1	71.0	60.1	59.6	59.6
Feb-10-1999	3	15	11	1.32	1.45	1.10	69.3	65.0	69.3	65.0	59.1	59.1
Jun-17-1999	3	3	23	1.03	1.01	1.34	49.6	52.9	49.6	52.9	56.3	56.3
Sep-17-1999	43	16	30	1.11	1.23	2.05	61.4	59.5	61.4	59.5	68.4	68.4
Nov-18-1999	3	14	4	0.80	1.36	0.93	55.6	59.1	55.6	59.1	53.3	53.3
Mar-02-2000	3	2	2	0.71	0.83	0.98	47.3	48.3	47.3	48.3	51.4	51.4
Jun-06-2000	3	3	3	0.92	0.86	0.87	43.3	44.4	43.3	44.4	44.1	44.1
Sep-27-2000	32	62	70	2.99	2.32	1.81	73.1	70.7	73.1	70.7	67.9	67.9
Nov-14-2000	3	2	10	1.23	0.87	1.76	54.8	45.4	54.8	45.4	57.9	57.9
Mar-07-2001	4	4	4	1.13	1.45	1.21	43.5	45.3	43.5	45.3	48.1	48.1
Jun-06-2001	3	2	3	1.07	0.80	0.79	45.0	44.4	45.0	44.4	46.0	46.0
Maximum	43	150	98	4.35	5.01	4.10	83.8	79.1	83.8	79.1	80.5	80.5
Minimum	2	2	2	0.58	0.80	0.79	35.2	44.4	35.2	44.4	44.1	44.1
Median	3	16	11	1.17	1.50	1.79	55.0	59.1	55.0	59.1	59.6	59.6
Average	12	32	25	1.73	1.93	1.90	59.5	59.6	59.5	59.6	60.8	60.8

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA
 March - September 1996 samples analyzed by US Bureau of Reclamation, Sacramento CA
 October 1996 - June 2001 samples analyzed by the US Geological Survey, Lakewood CO
 Reporting Limit: Selenium, 0.01 ug/g
 Significant Digits: Selenium, 2
 Organic Carbon, 2 or 3
 Percent Moisture, 2 or 3
 No sediment samples were collected at this site during the fifteen month study period (October 1, 2001 - December 31, 2001)

Table 2. San Luis Drain near terminus (Station B) Sediment Monitoring Results

Sampling Date	0-3 cm ug/g, dry weight	Selenium Concentration 3-8 cm ug/g, dry weight	Whole Core ug/g, dry weight	0-3 cm %	3-8 cm %	Organic Carbon Whole Core %	0-3 cm %	Percent Moisture 3-8 cm %	Percent Moisture Whole Core %
Mar-12-1996	19	12	30	2.70	2.81	2.15	64.7	59.9	59.0
Jun-27-1996	11	18	20	3.85	3.75	2.08	66.5	61.7	51.2
Sep-04-1996	24	41	40	1.97	1.89	3.45			
Nov-12-1996	26	48	42	2.49	2.36	2.66			
Mar-13-1997	14	27	0	2.14	2.95	0.07	40.0	49.0	58.0
Sep-11-1997	21	61	48	2.39	2.82	1.84	65.9	61.4	53.8
Nov-18-1997	15	28	41	1.62	1.86	1.73	53.8	44.2	50.2
Mar-03-1998	18	41	45	1.46	1.70	1.73	50.8	51.4	54.3
Jun-03-1998	11	21	26	0.85	1.51	1.09	46.6	54.0	46.1
Sep-29-1998	13	15		1.51	1.64		85.9	79.5	NT
Nov-09-1998	17	17	17	1.68	1.74	1.76	73.2	80.8	56.7
Feb-09-1999	15	31	23	0.94	1.93	1.87	61.3	60.9	72.7
Jun-18-1999	17	27	31	1.45	1.84	1.28	56.1	61.4	47.1
Sep-16-1999	20	29	26	1.65	2.03	1.57	51.7	54.7	59.2
Nov-17-1999	38	21	39	2.23	1.96	1.92	58.8	55.6	55.9
Mar-01-2000	65	28	29	1.80	0.99	1.32	59.1	53.8	43.2
Jun-06-2000									
Sep-27-2000									
Nov-14-2000									
Mar-07-2001	18	53	110	0.67	1.86	2.89	31.5	49.6	59.4
Maximum	65	61	110	3.85	3.75	3.45	85.9	80.8	72.7
Minimum	11	12	0	0.67	0.99	0.07	31.5	44.2	40.9
Median	18	28	30	1.68	1.89	1.76	58.8	55.6	54.3
Average	21	30	34	1.85	2.10	1.77	57.7	58.5	53.8

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA
 March -September 1996 samples analyzed by US Bureau of Reclamation, Sacramento CA
 October 1996 - June 2001 samples analyzed by the US Geological Survey, Lakewood CO
 Reporting Limit: Selenium, 0.01 ug/g
 Significant Digits: Selenium, 2 Organic Carbon, 2 or 3 Percent Moisture, 2 or 3

Table 3. Mud Slough above drainage discharge (Station C): Sediment Monitoring Results

Sampling Date	0-3 cm ug/g, dry weight	3-8 cm ug/g, dry weight	Selenium Concentration ug/g, dry weight	Whole Core ug/g, dry weight	0-3 cm %	3-8 cm %	Organic Carbon Whole Core %	0-3 cm %	3-8 cm %	Percent Moisture Whole Core %
Mar-12-1996										
May-20-1996	0.20	0.20	0.10	0.80	0.60	0.60	38.5	39.4	36.6	
Jun-27-1996	0.10	0.05	0.10	0.49	0.40	0.14	34.0	30.0	25.2	
Sep-04-1996	0.30	0.10	0.05	0.38	0.53	0.53	33.1	36.5	40.6	
Nov-12-1996	0.16	0.17	0.31	0.26	0.28	0.95				
Mar-12-1997	0.15	0.05	0.11	0.35	0.28	0.68				
Jun-09-1997	0.11	0.20	0.05	0.31	0.27	0.16	30.0	53.0	28.0	
Sep-11-1997	0.23	0.12	0.44	0.41	0.19	0.92	32.7	24.3	38.6	
Nov-17-1997	0.10	0.10	0.27	0.18	0.32	0.32	28.7	26.7	65.5	
Mar-03-1998										
Jun-04-1998	0.26	0.31	0.10	0.58	0.62	0.33	35.3	29.4	49.2	
Sep-28-1998	0.40	0.35	0.31	0.77	0.70	0.53	40.7	39.1	35.2	
Nov-09-1998	0.34	0.23	0.14	0.55	0.66	0.33	35.1	32.1	30.7	
Feb-09-1999	0.20	0.13	0.51	0.28	0.21	0.85	33.5	30.7	34.2	
Jun-18-1999	0.29	0.19	0.25	0.40	0.22	0.20	34.3	25.3	28.1	
Sep-16-1999	0.27	0.32	0.25	0.60	0.67	0.54	36.9	35.5	36.8	
Nov-17-1999	0.10	0.10	0.15	0.15	0.25	1.12	30.2	30.4	32.0	
Mar-01-2000	3.90	0.05	0.05	2.08	0.37	0.45	28.4	34.8	31.6	
Jun-07-2000	0.10	0.13	0.05	0.23	0.37	0.14	26.2	21.5	20.3	
Sep-27-2000	0.16	0.17	0.15	0.42	0.41	0.32	30.0	30.1	28.0	
Nov-14-2000	0.05	0.05	0.11	0.15	0.12	0.07	28.7	23.5	22.2	
Mar-14-2001	0.19	0.23	0.40	0.33	0.28	0.59	25.5	24.8	29.3	
Jun-04-2001	0.14	0.12	0.13	0.65	0.33	0.37	37.6	32.1	28.8	
Aug-08-2001	0.16	0.19	0.16	0.46	0.43	0.41	30.0	26.5	32.1	
Nov-13-2001	0.09	0.10	0.08	0.02	0.29	0.15	28.9	31.6	27.9	
Mar-01-2002	0.10	0.23	0.10	0.07	0.34	0.10	27.6	28.4	24.4	
Jun-18-2002	0.18	0.11	0.12	0.27	0.43	0.60	28.4	28.5	29.8	
Sep-24-2002	0.19	0.13	0.15	0.39	0.29	0.39	22.4	25.5	29.1	
Nov-13-2002	0.10	0.19	0.07	0.10	0.48	0.17	27.1	31.6	30.1	
Maximum	3.90	0.35	0.51	2.08	0.70	1.12	40.7	53.0	65.5	
Minimum	0.05	0.05	0.05	0.02	0.12	0.07	22.4	21.5	20.3	
Median	0.16	0.13	0.12	0.38	0.34	0.39	30.0	30.1	30.1	
Average	0.32	0.16	0.17	0.44	0.38	0.44	31.4	30.9	32.6	

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA

March - September 1996 samples analyzed by US Bureau of Reclamation, Sacramento CA

October 1996 - November 2002 samples analyzed by the US Geological Survey, Lakewood CO

Reporting Limit: Selenium, 0.01 ug/g

Significant Digits: Selenium, 2 or 3

Organic Carbon, 2 or 3

Percent Moisture, 2 or 3

Table 4. Mud Slough below drainage discharge (Station D): Sediment Monitoring Results

Sampling Date	0-3 cm ug/g, dry weight	Selenium Concentration 3-8 cm ug/g, dry weight	Whole Core ug/g, dry weight	0-3 cm %	3-8 cm %	Organic Carbon Whole Core %	0-3 cm %	3-8 cm %	Percent Moisture Whole Core %
Mar-12-1996	0.05	0.10	0.05	0.50	0.50	0.50	23.9	25.2	23.7
Apr-03-1996	0.40	0.40	0.20	0.26	0.35	0.19	32.9	26.2	28.5
Jun-27-1996	0.20	0.20	0.20	0.22	0.20	0.20	25.8	27.0	26.5
Sep-04-1996	0.14	0.25	0.17	0.14	0.12	0.12			
Nov-13-1996	0.46	0.27	0.76	0.28	0.17	0.28			
Mar-12-1997	0.12	0.05	0.16	0.07	0.06	0.11	21.0	21.0	25.0
Jun-09-1997	0.53	0.29	0.33	0.24	0.22	0.16	27.7	28.5	22.6
Sep-11-1997	0.72	0.24	0.24	0.54	0.09	0.14	30.4	25.8	18.8
Mar-03-1998	0.63	1.20	1.30	0.26	1.10	0.68	27.2	34.8	38.9
Jun-03-1998	0.64	0.47	0.50	0.29	0.27	0.21	34.6	27.7	26.5
Sep-29-1998	0.34	0.23	0.45	0.15	0.13	0.18	30.0	29.2	33.3
Nov-10-1998	0.29	0.40	0.38	0.18	0.27	0.51	26.6	28.0	32.6
Feb-09-1999	0.60	0.60	0.83	0.79	0.54	0.72	38.0	35.6	35.6
Jun-18-1999	0.68	0.53	0.81	0.44	0.51	0.85	36.7	35.0	39.8
Sep-16-1999	0.81	0.54	0.67	0.60	0.55	0.42	40.4	33.7	29.5
Nov-17-1999	0.71	0.83	0.34	0.41	1.10	0.19	33.6	31.2	19.8
Mar-01-2000	0.12	0.14	0.17	0.16	0.15	0.19	23.0	20.8	21.9
Jun-07-2000	0.39	0.22	0.35	0.18	0.13	0.22	37.0	25.8	23.5
Sep-27-2000	0.11	0.12	0.24	0.13	0.13	0.08	29.0	24.1	16.2
Nov-14-2000	0.21	0.23	0.23	0.06	0.09	0.06	18.2	19.8	20.2
Mar-14-2001	0.20	0.19	0.20	0.17	0.14	0.13	24.1	26.0	25.0
Jun-04-2001	0.26	0.19	0.14	0.14	0.12	0.09	24.5	18.0	20.5
Aug-08-2001	0.15	0.09	0.15	0.06	0.08	0.08	24.1	25.1	25.5
Nov-13-2001	0.11	0.10	0.16	0.08	0.08	0.01	19.6	18.8	23.3
Mar-01-2002	0.14	0.10	0.14	0.14	0.12	0.12	25.8	22.5	24.5
Jun-18-2002	0.50	0.32	0.22	0.12	0.14	0.09	25.4	22.5	18.4
Sep-24-2002	0.34	0.20	0.28	0.07	0.05	0.08	19.7	22.0	22.5
Nov-13-2002	Maximum	0.81	1.20	1.30	0.79	1.10	0.85	40.4	35.6
Minimum	0.05	0.05	0.05	0.06	0.05	0.01	18.2	18.0	16.2
Median	0.34	0.23	0.24	0.18	0.14	0.18	26.6	25.8	24.5
Average	0.36	0.32	0.36	0.25	0.27	0.24	28.0	26.2	25.7

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA

March -September 1996 samples analyzed by US Bureau of Reclamation, Sacramento CA

October 1996 - November 2002 samples analyzed by the US Geological Survey, Lakewood CO

Reporting Limit: Selenium, 0.01 ug/g

Significant Digits: Selenium, 2

Organic Carbon, 2 or 3

Percent Moisture, 2 or 3

Table 5. Mud Slough at Highway 140 (Station E): Sediment Monitoring Results

Sampling Date	0-3 cm ug/g, dry weight	Selenium Concentration 3-8 cm ug/g, dry weight	Whole Core ug/g, dry weight	0-3 cm %	3-8 cm %	Organic Carbon Whole Core %	0-3 cm %	3-8 cm %	Percent Moisture Whole Core %
Mar-12-1996									
May-20-1996	0.10	0.10	0.10	0.70	1.00	0.70	41.1	35.8	34.5
Jun-27-1996	0.10	0.10	0.50	1.08	0.45	0.40	37.9	32.7	30.9
Sep-04-1996									
Nov-13-1996	0.72	0.71	0.70	0.38	0.30	0.31			
Mar-13-1997	0.82	1.00	1.00	0.12	0.16	0.06			
Jun-09-1997	1.50	1.60	1.50	0.65	0.72	0.74	44.0	40.0	44.0
Sep-11-1997	1.60	1.30	1.90	0.69	0.52	0.78	42.0	34.2	45.8
Nov-17-1997	0.83	2.00	1.20	0.29	0.31	0.39	29.3	27.7	29.3
Mar-03-1998									
Jun-03-1998									
Sep-29-1998	0.24	0.18	0.25	0.16	0.18	0.21	31.6	26.7	26.8
Nov-10-1998	0.25	0.18	0.30	0.13	0.15	0.39	31.8	25.6	32.5
Feb-09-1999	0.32	0.48	0.78	0.32	0.54	0.45	37.4	38.0	43.5
Jun-18-1999	0.48	0.30	0.47	0.24	0.16	0.32	33.1	27.4	49.7
Sep-17-1999	0.96	0.54	0.20	0.44	0.24	0.08	44.0	29.9	8.2
Nov-18-1999	0.38	0.17	0.39	0.17	0.13	0.26	28.0	28.4	30.7
Mar-02-2000	0.19	0.13	0.23	0.32	0.13	0.23	36.0	36.2	27.1
Jun-07-2000	0.29	0.26	0.78	0.19	0.19	0.30	26.6	19.1	30.4
Sep-27-2000	0.54	0.46	0.93	0.20	0.23	0.51	33.4	29.3	29.4
Nov-14-2000	0.56	0.18	0.32	0.30	0.14	0.22	20.0	17.5	20.2
Mar-14-2001	0.68	0.54	0.36	0.40	0.07	0.11	29.6	26.2	27.0
Jun-06-2001	0.33	0.78	0.55	0.18	0.28	0.27	28.0	30.2	19.7
Aug-08-2001	0.36	0.47	0.59	0.14	0.24	0.24	20.2	21.7	25.1
Nov-13-2001	0.80	0.45	0.31	0.25	0.37	0.15	26.7	32.3	28.0
Mar-01-2002	0.38	0.46	0.74	0.15	0.20	0.26	24.6	20.6	26.8
Jun-19-2002	0.77	1.10	0.48	0.37	0.46	0.31	34.7	32.7	28.3
Sep-24-2002	0.51	0.41	0.81	0.16	0.21	0.45	23.9	22.7	32.0
Nov-13-2002	1.50	1.20	1.10	0.58	0.54	0.57	42.7	37.9	39.7
Maximum	1.60	2.00	1.90	1.08	1.00	0.78	44.0	40.0	49.7
Minimum	0.10	0.10	0.10	0.12	0.07	0.06	20.0	17.5	8.2
Median	0.51	0.46	0.55	0.29	0.24	0.31	31.8	29.3	29.4
Average	0.61	0.60	0.66	0.34	0.32	0.35	32.5	29.3	30.9

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA

March - September 1996 samples analyzed by US Bureau of Reclamation, Sacramento CA

October 1996 - November 2002 samples analyzed by the US Geological Survey, Lakewood CO

Reporting Limit: Selenium, 0.01 ug/g

Significant Digits: Selenium, 2

Organic Carbon, 2 or 3

Percent Moisture, 2 or 3

Table 6. Salt Slough at Highway 165 (Station F): Sediment Monitoring Results

Sampling Date	0-3 cm ug/g, dry weight	Selenium Concentration 3-8 cm ug/g, dry weight	Whole Core ug/g, dry weight			0-3 cm %	Organic Carbon 3-8 cm %	Whole Core %	0-3 cm %	3-8 cm %	Percent Moisture Whole Core %
			0-3 cm %	3-8 cm %	Whole Core %						
Mar-12-1996	0.60	0.50	0.20	0.69	0.58	0.18	0.25	0.12	41.9	33.3	28.9
Jun-27-1996	0.40	0.80	0.40	0.44	0.75	0.25	0.05	0.16	38.7	40.6	29.7
Sep-05-1996	0.24	0.40	0.25	0.05	0.16	0.05	0.32	0.36	26.0	20.0	29.0
Nov-13-1996	0.94	0.36	0.57	0.56	0.36	0.23	0.22	0.23	28.0	26.9	23.8
Mar-13-1997	0.12	0.14	0.35	0.08	0.12	0.26	0.11	0.23	47.3	46.9	44.6
Jun-09-1997	0.59	0.73	0.74	0.23	1.16	1.43	1.12	1.12	42.0	70.0	42.2
Sep-12-1997	1.30	1.90	1.40	1.16	1.43	1.12	0.21	0.21	2.11	31.2	50.7
Nov-18-1997	2.10	1.80	1.60	2.32	1.97	0.49	0.59	0.59	0.19	34.8	29.2
Mar-04-1998	0.66	1.00	1.30	0.49	0.26	0.31	0.23	0.21	0.26	26.8	26.1
Jun-04-1998	0.33	0.48	0.59	0.26	0.21	0.26	0.33	0.26	0.33	26.7	33.7
Sep-29-1998	0.28	0.55	0.70	0.21	0.26	0.19	0.19	0.19	0.19	30.5	31.6
Nov-10-1998	0.59	0.56	0.93	0.40	0.32	0.22	0.27	0.27	0.37	29.8	28.5
Feb-09-1999	0.37	0.52	0.70	0.22	0.24	0.53	0.22	0.22	0.22	35.5	28.6
Jun-18-1999	0.53	0.65	0.62	0.49	0.33	0.24	0.26	0.26	0.26	36.5	29.3
Sep-17-1999	0.27	0.25	0.42	0.23	0.29	0.26	0.26	0.26	0.26	23.8	21.2
Nov-18-1999	0.35	0.45	0.59	0.29	0.26	0.24	0.35	0.35	0.35	27.9	20.5
Mar-02-2000	0.30	0.37	0.52	0.24	0.24	0.24	0.24	0.24	0.24	36.8	33.8
Jun-07-2000	0.43	0.68	0.53	0.34	0.24	0.18	0.25	0.25	0.20	25.6	27.0
Sep-27-2000	0.22	0.39	0.52	0.18	0.25	0.25	0.20	0.20	0.20	29.1	37.0
Nov-14-2000	0.38	0.22	0.77	0.40	0.23	0.48	0.48	0.48	0.48	23.8	24.5
Mar-14-2001	0.66	0.44	0.73	0.21	0.22	0.27	0.27	0.27	0.27	27.4	24.6
Jun-06-2001	0.36	0.70	0.56	0.31	0.18	0.34	0.34	0.34	0.34	36.8	37.1
Aug-08-2001	0.20	0.23	0.30	0.38	0.42	0.46	0.46	0.46	0.46	28.9	31.0
Nov-13-2001	0.43	0.73	0.46	0.69	0.20	0.55	0.55	0.55	0.55	36.4	20.5
Mar-01-2002	0.36	0.71	0.24	0.27	0.31	0.29	0.29	0.29	0.29	25.5	25.6
Jun-19-2002	0.29	0.37	0.57	0.36	0.23	0.28	0.28	0.28	0.28	29.6	21.2
Sep-24-2002	0.51	0.59	0.28	0.30	0.20	0.16	0.16	0.16	0.16	28.1	20.1
Nov-13-2002	Maximum	2.10	1.90	1.60	2.32	1.97	2.11	2.11	47.3	70.0	50.7
Minimum	0.12	0.14	0.20	0.05	0.12	0.05	0.05	0.05	23.8	20.0	20.1
Median	0.38	0.52	0.57	0.33	0.26	0.29	0.29	0.29	29.1	28.0	28.6
Average	0.51	0.61	0.62	0.44	0.41	0.43	0.43	0.43	31.8	30.5	29.6

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA

March -September 1996 samples analyzed by US Bureau of Reclamation, Sacramento CA

October 1996 - November 2002 samples analyzed by the US Geological Survey, Lakewood CO

Reporting Limit: Selenium, 0.01 ug/g

Significant Digits: Selenium, 2 Organic Carbon, 2 or 3 Percent Moisture, 2 or 3

Table 7. Mud Slough backwater (Station I and I - 2): Sediment Monitoring Results

Sampling Date	0-3 cm		Selenium Concentration		Whole Core ug/g, dry weight	0-3 cm % ug/g, dry weight	3-8 cm % ug/g, dry weight	Organic Carbon Whole Core %	0-3 cm % ug/g, dry weight	3-8 cm % ug/g, dry weight	Percent Moisture Whole Core %
	ug/g, dry weight	ug/g, dry weight	3-8 cm	0-3 cm							
Jun-13-1996	0.40	0.40	0.40	0.30	1.60	1.30	1.20	1.20	7.8	17.2	24.9
Mar-13-1997	1.50	0.80	0.40	1.76	0.79	0.56	0.55	26.4	20.6	20.3	
Jun-03-1998	0.30	0.20	0.20	0.47	0.69	0.55	0.55	16.1	25.1	25.9	
Jun-18-1999	4.80	4.50	4.40	1.90	1.89	1.96	1.96	44.3	33.7	30.8	
Mar-01-2000	0.16	1.70	0.99	0.43	1.35	0.90	0.90	4.6	20.9	20.1	
Jun-07-2001	4.40	2.20	1.70	1.92	1.55	1.39	1.39	1.23	39.6	29.1	33.8
Nov-14-2000	3.50	1.50	2.20	1.91	1.17	1.23	1.23	28.3	30.5	33.3	
Mar-14-2001	0.81	1.30	1.60	0.80	1.16	1.01	1.01	0.52	36.5	34.3	32.2
Jun-06-2001	0.48	0.25	0.35	0.49	0.57	0.52	0.52	0.26	0.14	22.9	24.1
Aug-08-2001	0.34	0.32	0.21	0.26	0.28	0.14	0.14	1.51	60.9	48.2	49.8
Nov-14-2001	6.10	3.70	3.50	1.93	1.51	1.63	1.63	2.65	2.04	59.6	58.1
Mar-01-2002	8.30	5.70	2.60	2.65	2.58	2.04	2.04	6.20	2.17	61.4	51.1
Jun-18-2002	8.50	4.70	6.20	2.17	2.10	1.89	1.89	3.80	1.70	53.3	57.3
Sep-24-2002	7.00	4.50	3.80	1.70	0.62	1.84	1.84	5.00	2.70	49.6	52.8
Nov-13-2002	5.00	3.00	2.70	2.10	2.38	1.70	1.70	56.3	57.7	56.9	48.5
Maximum	8.50	5.70	6.20	2.65	2.58	2.04	2.04	61.4	58.1	57.3	
Minimum	0.16	0.20	0.20	0.26	0.28	0.14	0.14	1.70	4.6	17.2	20.1
Median	3.50	1.70	1.70	1.76	1.30	1.23	1.23	2.32	38.1	32.1	32.8
Average	3.44	2.32	2.08	1.47	1.33	1.24	1.24	37.3	35.8	36.1	

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA

June 1996 samples analyzed by US Bureau of Reclamation, Sacramento CA

March 1997 - November 2002 samples analyzed by the US Geological Survey, Lakewood CO

Reporting Limit: Selenium, 0.01 ug/g

Significant Digits: Selenium, 2 Organic Carbon, 2 or 3 Percent Moisture, 2 or 3

Table 8. San Luis Drain Annual Sediment Monitoring Results June 1997 – June 2001

Sampling Date	0-3 cm ug/g, dry weight	Selenium Concentration		Whole Core ug/g, dry weight	0-3 cm %	Organic Carbon %	0-3 cm %	Percent Moisture 3-8 cm %	Whole Core %
		3-8 cm ug/g, dry weight	3-8 cm ug/g, dry weight						
30' South of Check 1 (1-2 C)									
Jun-10-1997	9.6	47.0	26.0	1.19	1.93	1.69	36.0	51.0	52.0
Jun-03-1998	22.0	9.7	29.0	1.49	1.49	1.55	49.7	44.8	44.9
Jun-16-1999	5.3	8.5	59.0	0.81	0.97	2.13	50.2	39.8	58.7
Jun-05-2000	14.0	15.0	15.0	1.33	1.55	1.11	54.0	53.6	40.1
Jun-05-2001	8.9	11.0	14.0	1.53	1.59	1.78	61.3	54.7	60.3
Midpoint of Checks 1 & 2 (1-2 B)									
Jun-10-1997	39.0	96.0	51.0	2.11	2.25	1.56	56.0	53.0	47.0
Jun-03-1998	64.0	68.0	8.3	1.53	1.71	1.31	56.3	52.7	55.4
Jun-16-1999	8.8	11.0	14.0	1.30	1.45	1.53	62.9	57.6	55.8
Jun-05-2000	9.4	8.4	18.0	1.35	1.27	1.46	65.9	59.6	57.1
Jun-05-2001	9.5	8.0	12.0	1.66	1.32	1.60	66.5	57.8	60.0
50' North of Check 2 (1-2 A)									
Jun-10-1997	NT	NT	NT	NT	NT	NT	NT	NT	NT
Jun-03-1998	15.0	NT	0.65	NT	0.97	42.6	NT	NT	38.2
Jun-16-1999	19.0	64.0	71.0	1.99	2.68	2.27	35.5	49.0	54.9
Jun-05-2000	14.0	29.0	67.0	0.85	1.12	1.66	25.0	32.2	44.1
Jun-05-2001	18.0	71.0	48.0	1.05	1.90	1.92	19.7	43.6	43.2
50' South of Check 10 (10-11 C)									
Jun-10-1997	7.2	15.0	31.0	1.28	1.34	2.67	50.0	57.0	42.0
Jun-04-1998	21.0	39.0	17.0	0.72	1.66	1.43	44.0	62.6	56.4
Jun-16-1999	19.0	75.0	16.0	0.93	2.07	1.34	43.8	61.5	52.8
Jun-05-2000	47.0	84.0	41.0	1.23	1.65	1.85	49.6	57.1	60.9
Jun-05-2001	39.0	140.0	33.0	1.32	3.05	1.74	36.0	65.5	52.0
Midpoint of Checks 10 & 11 (10-11 B)									
Jun-10-1997	11.0	12.0	NT	1.57	1.16	NT	59.0	48.0	NT
Jun-04-1998	7.5	8.7	17.0	0.91	0.93	1.43	54.0	45.1	72.6
Jun-16-1999	26.0	8.4	6.0	1.24	0.89	0.56	51.5	52.8	39.4
Jun-05-2000	7.5	22.0	5.8	1.28	0.99	0.93	61.4	52.8	53.2
Jun-05-2001	10.0	14.0	1.40	1.86	1.43	1.43	54.1	60.7	61.8

Table 8 (Cont). San Luis Drain Annual Sediment Monitoring Results June 1997 - June 2001

Sampling Date	0-3 cm ug/g, dry weight	Selenium Concentration 3-8 cm ug/g, dry weight	Whole Core ug/g, dry weight	0-3 cm %	3-8 cm %	Organic Carbon Whole Core %	0-3 cm %	3-8 cm %	Percent Moisture Whole Core %
50' North of Check 11 (10-11 A)									
Jun-10-1997	24.0	43.0	39.0	1.41	1.97	1.83	48.0	57.0	53.0
Jun-04-1998	18.0	55.0	50.0	1.14	2.57	1.68	47.2	61.2	53.5
Jun-16-1999	14.0	26.0	45.0	0.61	1.82	1.56	34.7	47.1	53.1
Jun-05-2000	12.0	58.0	51.0	0.66	2.55	1.69	32.1	64.4	54.1
Jun-05-2001	16.0	64.0	50.0	1.25	2.51	2.31	36.3	59.8	50.4
50' South of Check 14 (14-15 C)									
Jun-11-1997	7.1	34.0	8.0	1.54	2.62	1.93	63.0	70.0	63.0
Jun-04-1998	31.0	11.0	42.0	0.85	1.96	1.11	45.2	67.4	42.3
Jun-16-1999	4.0	11.0	13.0	1.00	1.87	1.30	60.3	63.6	62.0
Jun-05-2000	5.3	4.8	45.0	1.34	1.36	2.41	60.6	41.0	63.1
Jun-05-2001	4.9	4.8	14.0	1.11	1.17	2.66	52.1	51.3	62.5
Midpoint of Checks 14 & 15 (14-15 B)									
Jun-11-1997	2.9	22.0	10.0	0.38	1.11	1.91	29.0	49.0	56.0
Jun-04-1998	3.4	3.4	5.7	1.04	1.08	1.17	55.2	54.9	58.0
Jun-17-1999	3.0	3.1	3.0	0.95	0.96	0.94	58.0	56.0	52.6
Jun-06-2000	3.3	4.1	3.1	1.03	0.99	0.93	56.0	52.5	53.3
Jun-05-2001	5.1	4.7	5.1	1.24	1.15	1.19	61.5	56.8	57.6
50' North of Check 15 (14-15 A)									
Jun-11-1997	40.0	48.0	3.8	2.37	2.83	0.59	63.0	67.0	63.0
Jun-04-1998	29.0	47.0	59.0	1.46	2.87	3.21	51.8	65.5	68.7
Jun-17-1999	43.0	76.0	76.0	3.64	3.23	2.84	61.9	65.2	63.5
Jun-06-2000	23.0	76.0	55.0	0.79	2.42	2.32	35.3	53.5	53.0
Jun-05-2001	43.0	76.0	62.0	2.13	2.93	2.37	37.4	62.2	56.9
Midpoint of Checks 17 & 18 (17-18 B)									
Jun-10-1997	2.7	3.5	3.8	0.67	0.80	1.82	46.0	45.0	66.0
Jun-03-1998	2.0	2.8	2.7	0.57	0.83	0.90	24.8	34.1	44.9
Jun-17-1999	2.3	1.6	1.6	0.59	0.71	0.52	45.5	37.9	40.3
Jun-06-2000	2.2	2.0	1.9	0.76	0.66	0.59	36.3	38.9	38.9
Jun-06-2001	1.8	2.0	2.1	0.47	0.60	0.54	34.3	35.6	39.6
50' North of Check 18 (17-18 A)									
Jun-10-1997	48.0	66.0	100.0	2.37	1.92	2.98	57.0	54.0	60.0
Jun-03-1998	35.0	65.0	75.0	1.25	2.39	2.33	38.0	53.8	57.4
Jun-17-1999	38.0	100.0	87.0	1.11	5.19	3.16	47.6	62.2	61.6
Jun-06-2000	26.0	49.0	43.0	0.81	1.84	1.54	35.6	47.9	45.7
Jun-06-2001	11.0	32.0	50.0	0.96	2.10	1.96	40.7	58.8	46.7

Notes:

All samples collected by the US Bureau of Reclamation, Sacramento CA

All samples analyzed by the US Geological Survey, Lakewood CO

Reporting Limit: Selenium, 0.01 ug/g

Significant Digits: Selenium, 2 Organic Carbon, 2 or 3 Percent Moisture, 2 or 3

Table 9. Annual sediment sampling in the San Luis Drain, June 2002

Notes:

- (1) Sampling interval using 20 samples = 6,791feet

(2) Sampling program designed by Bob Young, US Bureau of Reclamation

(3) Sampling interval using 20 samples = 6,791feet

(4) All samples collected by the US Bureau of Reclamation, Sacramento CA, June 2002

(5) All samples analyzed by the US Geological Survey, Lakewood CO, September 2002

(6) Close to San Luis Drain near terminus (Station B)

(7) Close to San Luis Drain near South Dos Palos (Station A)

Figure 1. Selenium in Sediment at Station A (1996 - 2002)

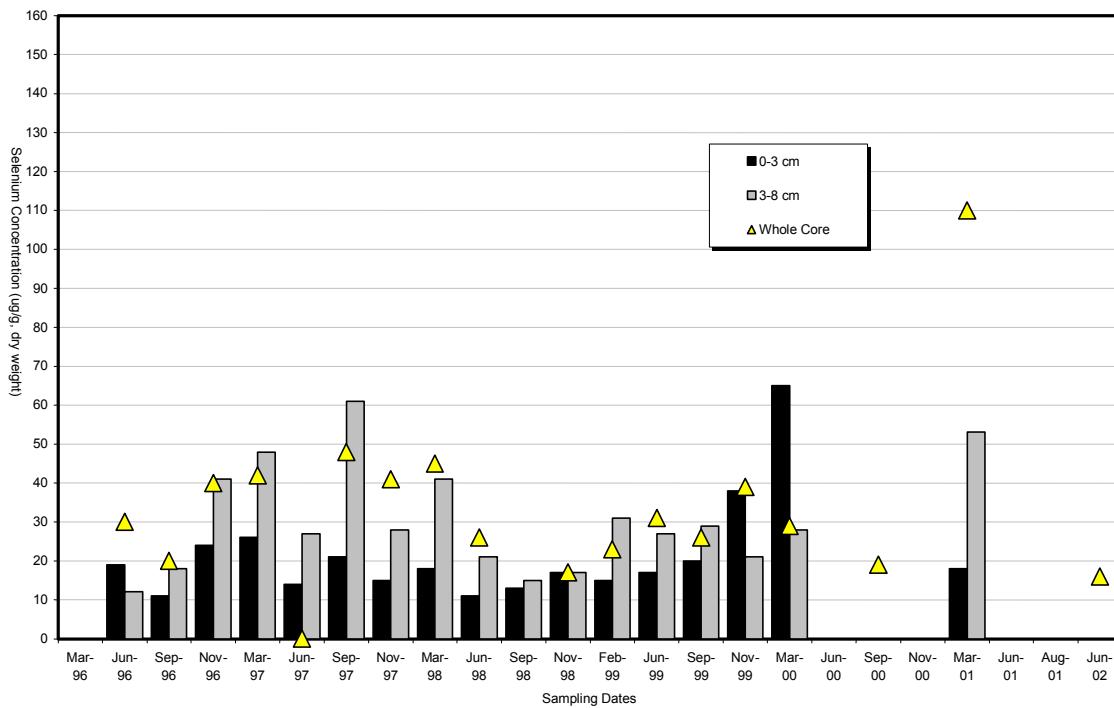


Figure 2. Selenium in Sediment at Station B (1996 - 2002)

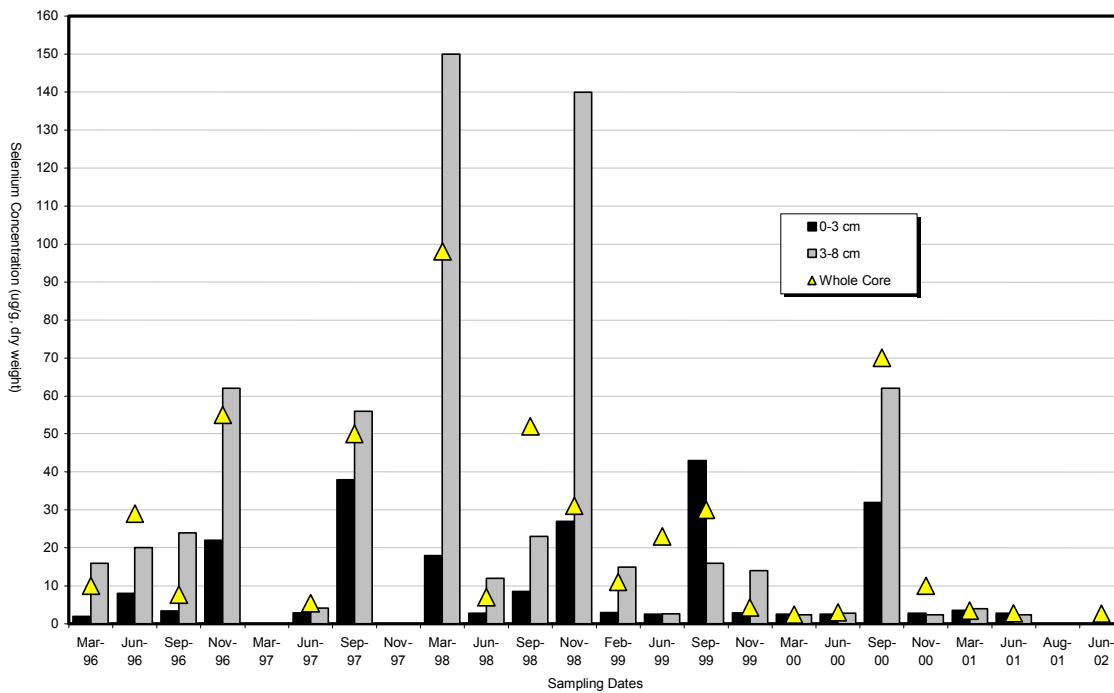


Figure 3. Selenium in Sediment at Station C (1996 - 2002)

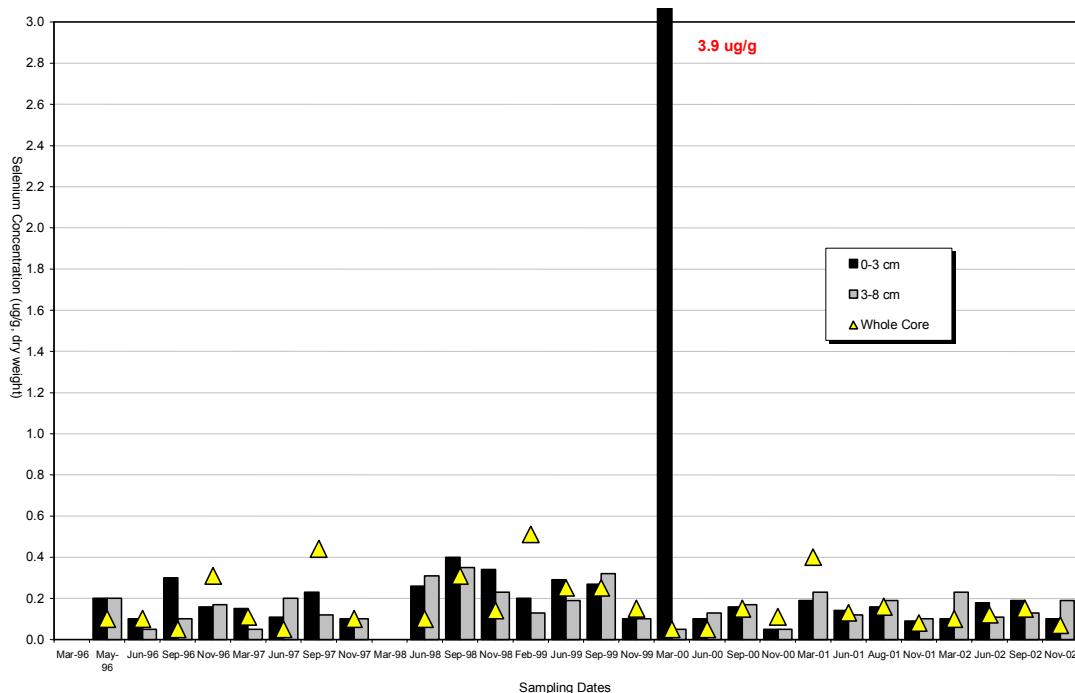


Figure 4. Selenium in Sediment at Station D (1996 - 2002)

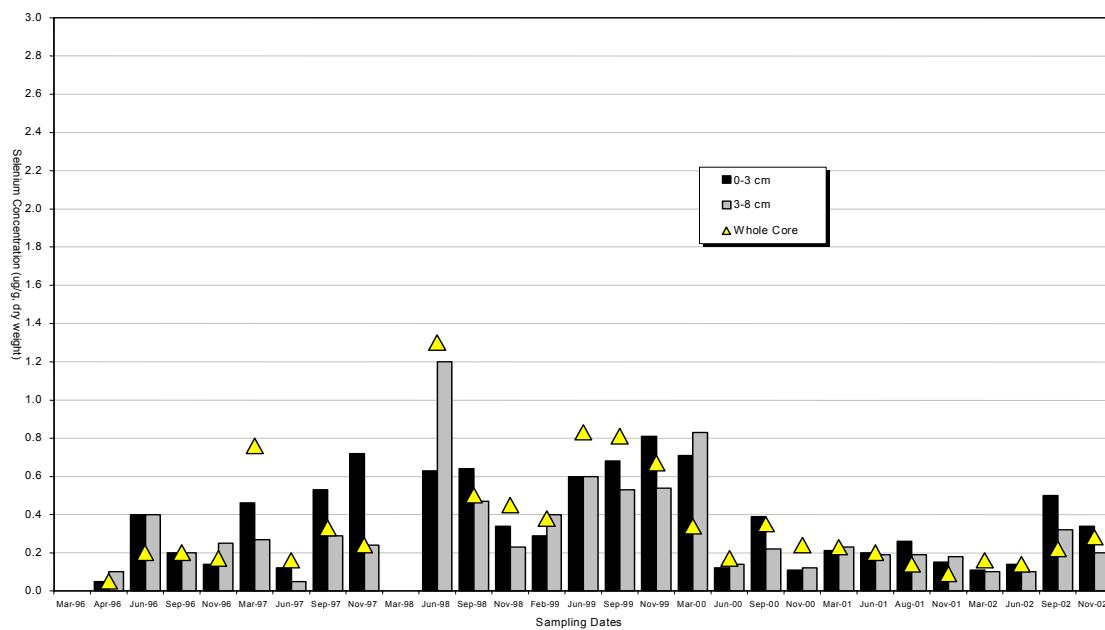


Figure 5. Selenium in Sediment at Station E (1996 - 2002)

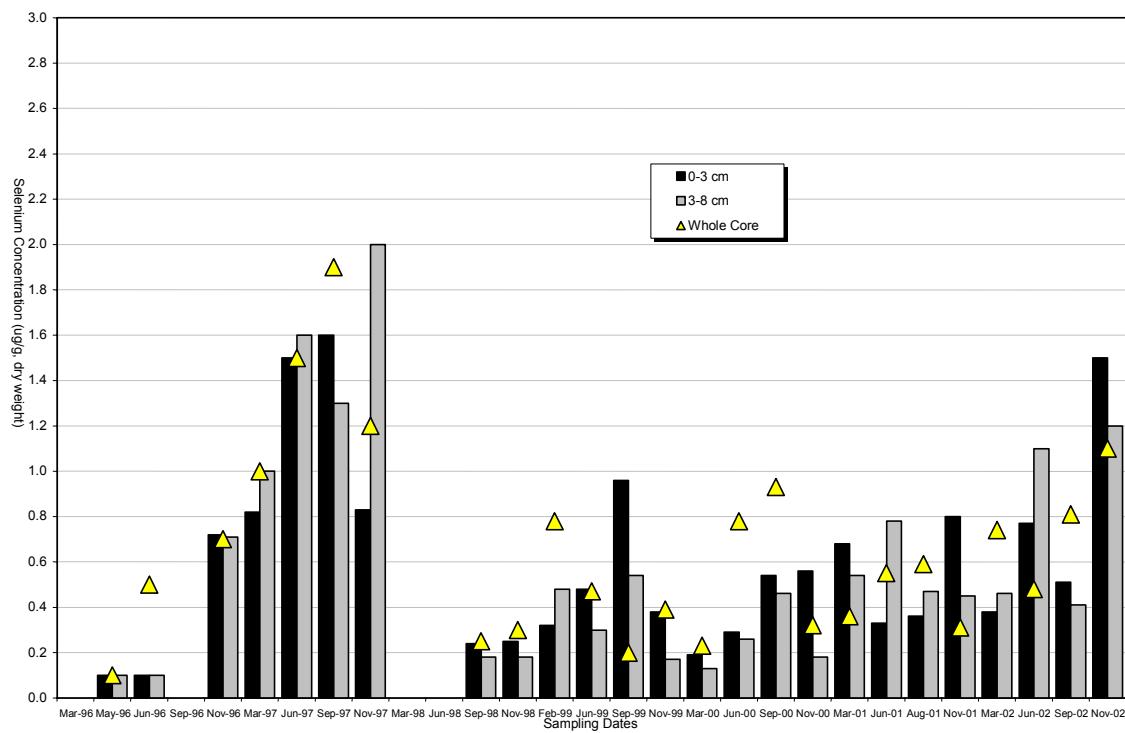


Figure 6. Selenium in Sediment at Station F (1996 - 2002)

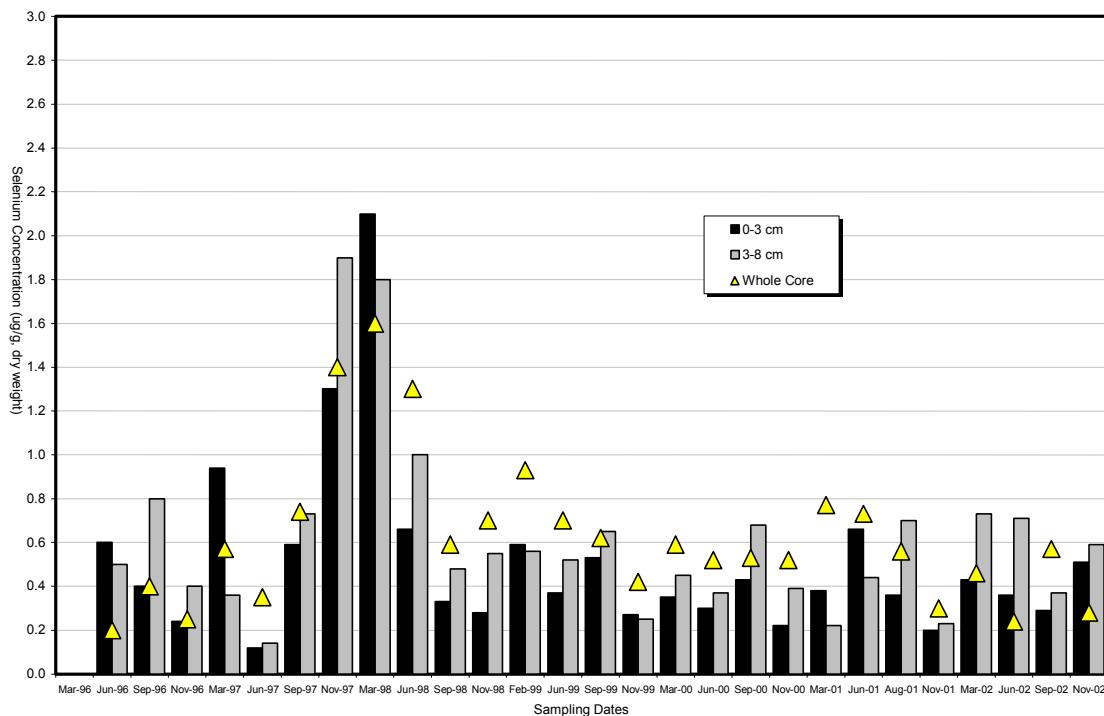


Figure 7. Selenium in Sediment at Stations I and I2 (1996 - 2002)

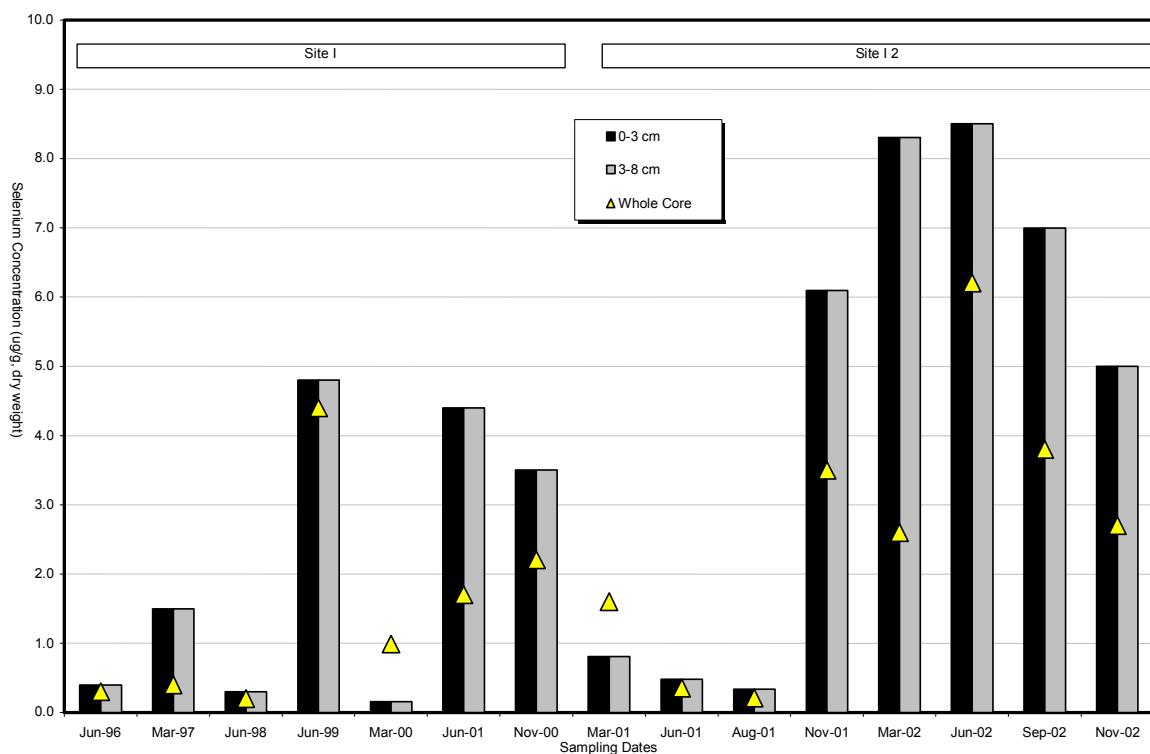


Figure 8. Selenium in Whole Core Samples of Sediment in the San Luis Drain (1997 - 2002)

